BULLETIN

OF THE

Society for the Promotion of Engineering Education

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COUNCIL ACTION.

By letter ballot the Council elected the persons whose names were listed in the September, October and November BULLETIN, with the exception of Messrs. Dietz and Gremple whose applications were received too late for the ballot. The above election is dated November 7.

APPLICANTS FOR ADMISSION.

BOYLE, A. C., Professor of Mining Engineering and Geology, University of Wyoming, Laramie, Wyo. 1911

FREEMAN, W. E., Professor of Electrical Engineering, University of Kentucky, Lexington, Ky. 1911

WALLIS, R. S., Instructor in Civil Engineering, Iowa State College, Ames, Iowa 1911

WATT, H. A., Instructor in English, University of Wisconsin, Madison, Wis. 1911

REPORTS OF DELEGATES TO THE NATIONAL CONSERVATION CONGRESS.

WASHINGTON UNIVERSITY,
SAINT LOUIS, MO.,
Oct. 20, 1911.

DEAN WILLIAM G. RAYMOND,
President, S. P. E. E.

My dear Professor Raymond: Allow me to submit herewith my report as delegate representing the Society at the Third Conservation Congress in Kansas City, on September 25, 26 and 27. From the official program you will note that the proceedings of this particular Congress were concerned especially with questions affecting agricultural and farm life. There was, however, an undercurrent, in all the considerations, of those interests affected by engineering, at different times. This fact was especially noticeable in the resolutions adopted the last day, which referred to many engineering questions; some of which would have appeared in different form if engineers had been represented in the councils of the Congress.

Besides the consideration of such allied interests represented by the conservation movement as economic and humanitarian questions, there are many interests that are common to our society and the Conservation Congress, as may be seen from the following quotations from a statement of their purposes.

"The field of conservation is very broad. It includes the forests, the waters, the lands and the minerals, our wild life and, as related to all these, the health of our citizens.

"For example, in the development of water power the Association believes it to be of the utmost importance to the people that in all federal or state grants, or franchises, the rights and interests of the people should be protected through adequate provisions for limitation of the grant to fifty years; prompt, full and orderly development on pain of forfeiture; the payment of a reasonable compensation, periodically readjusted; and the recognition of the rights of the appropriate public authorities to regulate rates and standards of service.

"The Association believes that the health of the people urgently demands

that vigorous steps be taken to prevent the pollution of the rivers and streams of the country, in order that purer and better water may be had for domestic and industrial use.

"At the same time the Association believes in and will give its vigorous support to measures, both legislative and administrative, looking toward the following:

"I. The protection and improvement of navigable rivers by forest conservation on their watersheds through the purchase or control by the nation of the necessary land, in coöperation with state and private action to the same end.

"II. The preparation, by a commission appointed by the President of the United States, of a comprehensive plan for inland waterway improvement, extending to all the uses of the waters and the benefits to be derived from their control."

The officials told me that they considered one of the most important actions of this Congress to be the legislation, which was enacted, authorizing an Advisory Board of the Congress, upon which each national society having a Conservation Committee shall have one representative. It seems to me that the advantage of this new arrangement will be mutually beneficial to both the Conservation Congress and to such national societies as feel justified in thus aiding the work of the Conservation Congress. I therefore write particularly of this proposition, which you no doubt will desire to lay before the Society for consideration.

My greetings extended to the Congress as representative of the Society for the Promotion of Engineering Education were as follows:

"At our annual convention of fifteen years ago a paper was presented on the subject of 'The Conservation of Government Energy through Education and Research' in which the statement is made with reference to our natural resources—'the Government must be possessed of large resources and a settled policy. Resources are not so easily commanded now as formerly. All sources must be guarded and everything realized must be successfully husbanded.'

"In the work of the engineering colleges, which distinctively consists in educating young men in those fundamental principles which particularly concern the direction of the great resources of materials and power in nature to the use and convenience of mankind, the student is trained to regard wastefulness as serious a fault as he does otherwise defective design.

"With this idea of the essential economy of their plans and works thus impressed, engineers have been filling their place in the development of the material resources of the republic for more than half a century, until there exists a body of trained men to whom conservation is an ingrained trait.

"Having this common ground of interest, it would seem that each organization may be of service to the other; that which I represent gaining an enlarged interest in those social, economic and moral questions which so vitally affect human welfare; and you, perhaps, utilizing the trained experience available to most fully disclose the true conditions upon which conclusions must depend, so that the principles advocated may always be based upon ascertained facts."

Very truly yours,
J. L. VAN ORNUM.

LAWRENCE, KAS.,
October 30, 1911.

DEAN W. G. RAYMOND,
IOWA CITY, IOWA.

Dear Dean Raymond: I was able to attend the Conservation Congress at Kansas City on only one day. I heard nothing that was especially interesting to me, either as an engineer or a teacher of engineering. Almost all of the program was centered around the one idea of soil conservation and was chiefly interesting to those directly engaged in farming or in occupations connected therewith. There were a number of delegates who represented various national societies, among those, Professor Gardner Williams, representing the American Society of Civil Engineers. There were a number who were connected with the A. A. A. S. who were interested in all sorts of questions connected with conservation. The delegates who represented various national scientific organizations formed a temporary organization very late in the day and arranged for a meeting by themselves at the Baltimore Hotel the next morning. There were some men present who evidently were interested in special schemes of "special interests" but these were not much in evidence and at that first meeting were pushed into the background by a resolution approving the idea

favoring the placing of scientific matters in the hands of trained scientific men.

F. O. MARVIN.

JOINT COMMITTEE ON ENGINEERING EDUCATION.

Chairman Desmond FitzGerald reports that the composition of the Committee at present is as follows:

Mr. F. W. Taylor, Philadelphia, Pa., and President A. C. Humphreys, Hoboken, N. J., representing the American Society of Mechanical Engineers.

Professor C. F. Scott, New Haven, Conn., and Professor Samuel Sheldon, Brooklyn, N. Y., representing the American Institute of Electrical Engineers.

Mr. Clifford Richardson, New York City, and Professor H. P. Talbot, Boston, Mass., representing the American Chemical Society.

Dr. H. M. Howe, New York City, and Dr. John Hays Hammond, New York City, representing the American Institute of Mining Engineers.

Mr. Desmond FitzGerald, Brookline, Mass., and Mr. B. M. Hatton, New Orleans, La., representing the American Society of Civil Engineers.

President Henry S. Pritchett, New York City, Professor J. M. White, Urbana, Ill., Professor C. L. Crandall, Ithaca, N. Y., and Professor D. C. Jackson, Boston, Mass.

Professor Jackson is Secretary of the Committee. He will try to keep the members of the Society posted regarding its work.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

The list of officers nominated by the Nominating Committee contains the names of several members of the Society for the Promotion of Engineering Education. The nominees are as follows: President, Alexander C. Humphreys, Hoboken, N. J.;

Vice-President (for two years), Wm. F. Durand, Stanford, Cal., Ira N. Hollis, Cambridge, Mass., Thos. B. Stearns, Denver, Col.; Managers (for three years), Chas. J. Davidson, Milwaukee, Wis., Henry Hess, Philadelphia, Pa., George A. Orrok, New York; Treasurer, Wm. H. Wiley, New York. All of the nominees have been notified and have accepted.

The Nominating Committee also contains several of our members. The complete committee consists of R. C. Carpenter, Chairman, R. H. Fernald, A. M. Hunt, E. G. Spilsbury, C. J. H. Woodbury.

INAUGURATION OF PRESIDENT GEO. E. VINCENT.

The most notable event in the history of the University of Minnesota for more than a quarter of a century was the inauguration of Dr. Geo. E. Vincent as its third president, which took place on the 18th of October. The addresses on that occasion were all of a high order of merit, and that of President Vincent was notably so. He advocated the hearty, loyal cooperation of all the colleges and schools of the University as the best means for its most complete development and for its highest usefulness to the state. A notable circumstance, at this inaugural, was the presence of both of its former presidents on the platform, strong in body and in intellect, each of whom took a prominent part in the program.

Dr. Wm. Watts Folwell, the first President, presented the greetings of the Faculties, while Dr. Cyrus Northrop, the second President, and President Emeritus, in an admirable address, presented the President. The whole occasion, including the torchlight parade of the students and the fireworks on the evening of the 17th, the banquet on the evening of the 18th, and the automobile ride on the 19th, were carried out in a manner befitting the splendid spirit of this great institution. The students of the College of Engineering made a notable showing in the parade of the evening of the 17th. Each of the departments, Mechanical, Civil and Electrical, were finely

represented by both students and devices prepared by them to exhibit the work of these departments. A large number of

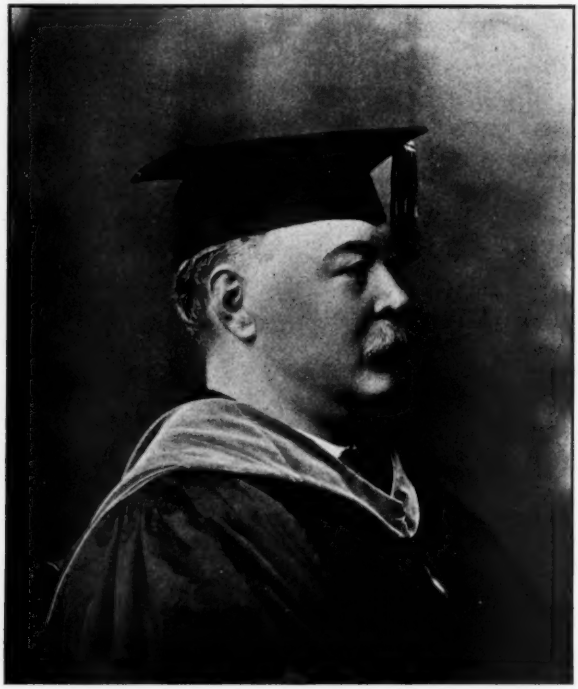
The three Presidents of the University of Minnesota. Standing, President Geo. E. Vincent; sitting, inside, ex-President William W. Folwell, the first President; sitting, outside, President Emeritus Cyrus Northrop.

notable delegates were present from other institutions, and the occasion was one long to be remembered for its inspiring addresses and its delightful fellowship.

INAUGURATION OF PRESIDENT THOS. E. HODGES.

The University of West Virginia is entering upon a new era in the history of its development, which apparently will be very favorable toward fostering engineering education in this state. Many important changes have been made this year in

the personnel of the administrative and instructive staff, not only of the University at large, but especially of the Engineering College. A new president of the University and a dean of the Engineering College have been installed, and additional instructors have been secured. Consequently, a reorganiza-



President Thos E. Hodges, of West Virginia University.

tion and coördination of the engineering departments has been effected which should result in a more efficient management of the business of the college. The ceremonies connected with the inauguration of President Thos. E. Hodges extended over four days replete with national, state and collegiate

greetings and appreciative acknowledgments. On the first day of November President Taft honored the University by his presence and delivered a congratulatory address as a representative of the nation. The following day addresses were delivered by Dr. F. B. Dresslar, of the United States Bureau of Education, and Dr. E. A. Alderman, President of the University of Virginia. The morning of November third was devoted to the formal reception of delegates and brief addresses of greeting from presidents of many universities. On the afternoon of the same day the formal inauguration of the new president was conducted by Governor Glasscock and Hon. M. P. Shawkey, President of the Board of Regents of the University. The inaugural address delivered by Dr. Hodges followed addresses from President Harry P. Judson, of Chicago University, and President W. O. Thompson, of Ohio State University. The evening hours were devoted to a reunion of alumni and a general reception. November fourth was called State Day, having been set aside as the occasion for addresses from many state officials and prominent alumni in considering the welfare of the University.—The attitude of the new president toward the Engineering College is especially favorable. Dr. Hodges was for many years a teacher of engineering physics and head of the department of physics. Later, as a member of the State Board of Control his influence was of great benefit to the financial welfare of our engineering departments. And now as president of the University, one of his first official acts was to have a deanship created for the Engineering College with a view of strengthening its organization.

JOHN WESLEY JOHNSON, PH.D.

Dr. J. W. Johnson, professor of physics in the University of Mississippi since 1899, died on August 21, 1911. He became a member of this society in 1907. "American Men of Science" gives the following excellent summary of Professor Johnson's career: He was born in Pontotoc, Miss., Apr. 5, 1852. He received the degree of A.B. (Mississippi, '76); A.M. (same, '79); and Ph.D (Leipzig, '92). He was assistant professor of Latin and mathematics at his *alma mater* from 1876 to 1881; principal of the Johnson Institute, Booneville, Miss., from 1881 to 1886; in the preparatory department of the University from 1886 to 1890; associate professor of physics in the University from 1892 to 1899; and professor of physics from 1899 to the time of his death. In addition to his work of instruction Professor Johnson was superintendent of education of Prentiss County, Miss., in 1885. His researches include those on the heat of obscure rays, osmosis in vegetable membranes, effect of the electric current on the direction of the spiral winding of morning-glory vines.

COLLEGE NEWS.

University of Colorado.—The Civil Engineering Department has recently completed the Roads Laboratory having now all of the apparatus required for testing road material, namely, Deval abrasion tester, impact or toughness machine, cementation tester, Dory hardness machine, drill and drill-press, diamond saw, etc., together with minor equipment necessary for a complete road testing laboratory. The road building materials of the State are being tested in conjunction with the State Highway Commission. Many tests have already been made, including some on asphaltic sand. A series of tests on the building stones of Colorado is just being completed including physical and mineralogical examination of the products from about 40 quarries. The building and ornamental stones of the State constitute one of its chief assets and it has been with a view to furnishing information concerning them that these tests have been made.—The U. S. Timber Testing Station which is located at the University of Colorado, working in conjunction with the Department of Civil Engineering, has made extensive study of the timber of the Rocky Mountain region. At present, work is being done on local wood, lodge pole pine and Douglas fir, the investigation including bending, compression, both parallel and perpendicular to the grain, shrinkage, hardness, shear and cleavage.—The Department of Civil Engineering recently made comparative tests on new bridge timbers (8 in. by 16 in. by 16 ft.) and old ones which had been in use in the 16th St. viaduct in Denver for 20 years. The results of these experiments will soon be published as a University bulletin.—The Department of Mechanical Engineering is investigating the heat values of the coals and lignites of the State, also the gasolene made from local fields. It is also collecting information concerning the various power plants of the State.

Colorado School of Mines.—George W. Schneider is the new Professor of Mining at the Colorado School of Mines and Carl A. Allen is Assistant Professor of Mining. Both are practical mining men and former graduates of the school. Professor Schneider graduated with the class of 1894 and has had a wide experience as State Mine Inspector and as a mining engineer and operator both in the United States and Mexico.—The Junior class in mining at the Colorado School of Mines spent from the 18th to the 21st of October inspecting placer and lode mining operations in the Breckenridge District, Colorado. They were accompanied by Professors Schneider and Allen.

Cornell University.—Professor V. Karapetoff is spending his sabbatical year with J. G. White & Co. Inc., engineers and contractors, 43 Exchange

Place, New York City. His time is divided among the various departments of the company, namely the financial, the business-getting, operating, construction, and engineering. His duties are essentially those of an efficiency expert, investigating the methods in vogue, making suggestions for improvements, securing better coöperation among the members of the staff, and planning for the future development of the company.

Harvard University.—George Chandler Whipple, of the firm of Hazen and Whipple, of New York, has accepted an appointment as Professor of Sanitary Engineering in the Graduate School of Applied Science at Harvard University. Mr. Whipple is well known in sanitary engineering work, having conducted many important researches and served in various professional capacities in connection with the water boards of Boston, Brooklyn and New York City. His books and writings have proved valuable contributions to his special subjects. During the last summer, a well-equipped laboratory for study and research in sanitary engineering has been fitted up in Pierce Hall, the engineering building at Harvard.

Idaho State University.—The following changes have occurred in the teaching staff: Mr. D. B. Steinman, instructor in Civil Engineering, has been advanced to an Assistant Professorship. In June last he received the degree Ph.D. from Columbia University, New York. His thesis on the "Economic Spans of Cantilever and Suspension Bridges" will be published in Van Nostrand's Science Series in October.—Mr. S. E. Hutton, last year with the University as *ad interim* Professor of Electrical and Mechanical Engineering, resigned in June to assume the duties of assistant general manager of the Idaho National Harvester Company with full charge of construction.—Mr. L. J. Corbett has been made Associate Professor of Electrical Engineering; the former head of the Department, Professor S. R. Sheldon, having chosen to remain in his present position as Professor of Electrical Engineering in the Chinese University at Shanghai, China. Professor Corbett graduated at the University of California in 1902, and has had varied practical experience since.—Mr. D. C. Livingston succeeds W. R. Chedsey, who resigned in June as Asociate Professor of Mining Engineering. Professor Livingston graduated from McGill University in 1906 and comes to the University of Idaho also from practical work. His last position was with the Phelps-Dodge Company as engineer of the Montezuma Copper Company.

University of Illinois.—Dr. N. C. Ricker, Professor of Architecture, and Professor I. O. Baker, in charge of the Department of Civil Engineering of the University of Illinois, have been appointed by Governor Deneen as members of the Commission to Revise and Codify the Building Laws of the State of Illinois, which Commission was authorized by

the last General Assembly of the state. The other members of the Commission are Mr. R. E. Schmidt, Mr. W. C. Armstrong and Mr. W. S. Stahl of Chicago, Mr. W. H. Merrill of Lake Forest and Mr. G. J. Jobst of Peoria. Dr. Ricker is chairman of the Commission.—At a meeting of the Urbana Section of the American Institute of Electrical Engineers held on October 11, the following officers were elected: E. H. Waldo, Chairman, T. D. Yensen, Vice-Chairman, F. G. Willson, Secretary, A. M. Buck, Treasurer. The section is in a flourishing condition and the outlook for the year is bright. It is expected that the section will draw to the University community several speakers of international reputation, in addition to holding meetings for the discussion of electrical problems and for social purposes. The Urbana section is composed largely of engineers connected with or interested in the University of Illinois.—During the vacation, the Department of Theoretical and Applied Mechanics conducted an extensive test of a reinforced concrete shoe factory building in Brooklyn, New York, a test of a reinforced warehouse in Chicago, and a test to destruction of a full-sized highway bridge of reinforced concrete, built for this purpose by the Illinois State Highway Commission in Chester, Illinois. In all of these tests actual stresses in various parts of the structures were measured. Much valuable information as to the location and magnitude of stresses in reinforced concrete structures in actual service was gained. Special apparatus and methods for measuring stresses in full-sized structures in actual service are being extensively developed by the Department.

Iowa State College.—One of the annual events at the college is an engineering campfire held every fall. This passed off very successfully on the evening of October 13. The affair was under the joint auspices of the Junior and Senior classes and the Engineering Faculty. At this meeting steps were taken for the formation of an engineers' club to include all engineering students, with the present Civil Engineering Society, local branch of the American Institute of Electrical Engineers, Agricultural Engineers Club, and Mining Seminar as affiliated organizations.—Detailed plans are being completed for the construction of a new mechanical laboratory building in 1912. The last legislature granted an appropriation of $50,000 for the construction and partial equipment of this building.—The Engineering Experiment Station is carrying on an investigation of the actual pressures resting upon sewer pipe and drain tile in ditches, which is showing interesting results. The annual appropriation for the Experiment Station was doubled by the last legislature.—The Iowa State College constitutes the State Highway Commission by state law, and the active work is done under the immediate supervision of the Division of Engineering. Additional funds were granted for this work by the last legislature, and it is growing rapidly.—The Iowa State College grants the degree of Bachelor of Science in Agricul-

tural Engineering upon the completion of a four years course which varies from the other engineering courses only in substituting some agricultural work in place of other technical work. The course seems to be popular at present, as the entering class this year numbers thirty-six.—A local chapter of the Honorary Fraternity Phi Kappa Phi was installed Monday, October 23, by President E. E. Sparks, of the Pennsylvania State College.

University of Kansas.—A new coal washing plant with a capacity of about ten tons a day has been established in the Department of Mining Engineering Laboratory. This will be used primarily for demonstration, but also for testing the coal which the University is using to determine whether or not it is desirable to wash it.—A special appropriation of $7,500 was made to the State Geological Survey for erecting and equipping a clay testing laboratory. A stone annex has been built adjoining the mining laboratory on the south, giving it the appearance of one building. This is approximately 22 by 60 feet in dimensions, and three stories high. The lower story has a 15 ft. ceiling and concrete floor on which will rest a 5 ft. wet-pan for grinding and tempering the clay, an auger machine with a variety of dies for producing various kinds of brick, hollow tile, roofing tile, etc., a hand-press for making dry-press brick, and also for repressing brick from the auger machine, and a special press with a number of standard molds for roofing tile. Suitable bins will be provided for holding samples of clay in two-ton lots. A kiln is built just outside the building so that the front or doors open into this room. The kiln will have one dry room with proper trucks and tracks, one down-draft kiln built on the latest approved plan for firing different kinds of ware, and one high temperature kiln. The kiln and clay preparation machinery will be moved into this room from the Fine Arts Department. This kiln is a muffle kiln and will be used for glazing purposes. The machinery is of a special pattern, small in size, obtained last year by the Fine Arts Department for the preparation of clay to be used in that department and is complete in itself, to receive raw clay at one end and deliver it at the other end from the filter pumps ready for immediate use.—The second floor of the new building is divided into five small research laboratories and a balance room. One of these is for investigations with the microscope, two for chemical laboratories, and two for physical laboratories. Each is a small room, but sufficiently large for the purposes intended. It is not expected that the students will occupy these rooms at all, excepting in the case of an advanced student employed for such work. These several laboratories are to be equipped with the latest and best appliances for high-grade investigations of clay.—Associate Professor W. C. Hoad has been advanced to a Professorship in the Department of Civil Engineering.—Associate Professor H. P. Cady has been advanced to a Professorship in the

Department of Chemistry.—Charles I. Corp has advanced from an Assistant to an Associate Professorship in the Department of Mechanical Engineering.—The following new appointments have been made: F. B. Dains, recently Professor of Chemistry at Washburn College, as Associate Professor of Organic Chemistry; W. A. Whitaker, Jr., recently in charge of Metallurgy at the College of the City of New York, as Associate Professor of Metallurgy; C. A. St. Clair (Ohio State, '10) and Oscar W. Melin (Univ. Wis., '10) as Instructors in Civil Engineering; Frank Rupert (Univ. Kan., '06 and '08) as Instructor in Chemistry; C. A. Haskins (Univ. Kan., '10) as Assistant Engineer for state sanitary work.

Lehigh University.—President James McCrea, of the Pennsylvania Railroad, in delivering the Founder's Day address at Lehigh, advocated the training of young men in college for activity in politics, municipal, state and national. Acting upon this suggestion, the students at this institution have organized the Lehigh Politics Club, to take up work along lines favored by Mr. McCrea.—Professor F. P. McKibben, head of the Department of Civil Engineering at Lehigh, has been appointed consulting engineer by the Pennsylvania state committee which is investigating the causes of the flood disaster at Austin.—Professor J. W. Richards, of the Department of Metallurgy, has returned from Norway, where, in September, he represented Lehigh at the 100th anniversary of the University of Christiania. "The industrial circles in Norway and Sweden," says Professor Richards, "are setting an example to the whole world of very cheap development of water power and its application to various new electro-chemical processes."—President H. S. Drinker attended the meeting of the American Institute of Mining Engineers at San Francisco. Dr. Drinker was one of the founders of the American Institute in 1871. He accompanied the Institute on a trip to Japan, setting sail on Oct. 17.

University of Maine.—The fall semester of the new year opened September 21 with 224 new students. Of this number 173 are regular freshmen. The total registration is 592. This number does not, however, include the Law School, the Summer School or the winter courses in agriculture. This addition will probably bring the total up to about 900. Of the above 592, 275 are registered in the College of Technology. This college is made up of the following courses: Chemistry, chemical engineering, civil engineering, electrical engineering, mechanical engineering and pharmacy.—A number of changes have occurred in the personnel of the faculty in this College of the University, the most important of which are the following: W. M. Curtis, formerly Assistant Professor of Mechanical Engineering, resigned his position last June to devote his time entirely to practical work. The college considers itself fortunate in securing Mr. Winslow H. Herschel for this position. Professor

Herschel graduated from Harvard in 1896. He has had wide experience in mechanical engineering, and has been for some time in Zurich, Switzerland, as technical correspondent for the Allis-Chalmers Company. He was for a time inspector for the Panama Canal Commission, being located at Pittsburgh.—Mr. C. H. Lekberg, Maine '07, comes from Crompton and Knowles Loom Works, Worcester, Mass., as Instructor in Mechanical Engineering.—The Civil Engineering Department has been reinforced by the addition of Mr. R. B. Kitridge, Maine '06, as Instructor, who since graduation has been engaged in railroad maintenance work.—The Electrical Engineering Department has been fortunate in retaining the services of Mr. A. T. Childs. His promotion to the rank of Assistant Professor is looked upon by all with favor.

University of Minnesota.—Classes are being held in the new Experimental Engineering Building which has been completed at a cost of $92,000, exclusive of equipment. It is a brick, stone and reinforced concrete structure with two floors and full basement, and has a total floor area of 33,000 square feet.—Professor F. H. Constant has returned after spending a year's leave of absence in study and travel abroad. The greater part of his time was spent in study under Professor George C. Mehrtens at the Technische Hochschule in Dresden, and also at the Technische Hochschule in Munich. During the summer of 1910 Professor Constant with his family toured through southern Bavaria and the Tyrol on bicycles. The past summer was spent in travel in Italy and France, ending with a bicycle tour through England and Scotland.

University of Mississippi.—A special laboratory equipment for storing, handling, and testing re-inforced concrete beams has recently been installed and is now in successful operation.—A laboratory for testing road-making material has been added.—Professor Walter H. Drane, formerly dean and Professor of Civil Engineering, is now Professor of Mathematics and Civil Engineering in Cumberland University, Lebanon, Tennessee.—Professor J. H. Dorroh, of the Engineering Department, is vice-president and member of the Board of Direction of the Mississippi Association of Civil Engineers, organized early in September of this year.

The University of Nebraska.—Mr. J. D. Hoffman, formerly Professor of Engineering Design at Purdue University and president of the American Society of Heating and Ventilating Engineers, has been elected to the position of Head Professor of Mechanical Engineering in the University of Nebraska to succeed Professor C. R. Richards, who has accepted a call to the head of the Mechanical Engineering Department of the University of Illinois. At the time of his resignation Professor Richards was dean of the Engineering College. Mr. A. Riddervold, of Chicago, graduate of the Technical College of Christiania, Norway, and

for some time post-graduate student at Hannover, Germany, has been appointed Assistant Professor of Civil Engineering to fill the place made vacant by the resignation of Professor Lockwood J. Towne, who has accepted a position with the University of Illinois. Mr. Riddervold will have charge of the work in structural engineering, having had some eight years practical experience in that line.—Professor P. J. Holden, formerly Professor of Engineering Design at Purdue, has been elected to the head of the Mining Engineering Department and Chancellor Avery is Acting Dean of the Engineering College.—Adj. Professor C. K. Shedd, of the Agricultural Engineering Department, has accepted a position as Assistant Professor of Agricultural Engineering at Ames, leaving his former position at Nebraska open.

New Mexico College of Agriculture and Mechanic Arts.—In view of the great development in irrigation in the State, there is being installed on the College premises a model pumping plant which will have a capacity of 1,100 gallons per minute. The plan when carried to completion will include all the essentials of a pumping plant which any person would need to use in installing a pumping plant for irrigation. The purpose of this installation is to afford an opportunity of experimenting with the problems which confront the irrigator who has to depend upon pumped water for irrigation purposes. The plant will consist of a No. 6 vertical centrifugal pump which will be driven by a 22 h.p. gasoline engine. The total head pumped against will be in the neighborhood of 25 to 30 feet, depending upon the draw-down. In connection with this plant will be placed a box large enough to hold measuring devices of various types and some of which are new. These various devices will be tested for various flows and the water will be measured volumetrically in a carefully calibrated cement tank. This tank will be $45' \times 50'$ and 4.5′ deep. It will hold an hour's pumping from this 6″ centrifugal pump at 1,100 gallons per minute. From the tank there will lead a 12″ main to a point which will command an area sufficiently large to demonstrate the various methods of handling water economically and also simple measuring devices for measuring water correctly. This area is sufficiently large to make comparative tests on the amounts of water used for various systems of distribution. By such a distribution it will be an easy matter to determine the most economical methods to use for various crops. It will also be of considerable educational value in that it will serve to put before the interested party a system which he may adopt and increase the growing or producing value of the water he pumps. The pumping plant also affords an excellent laboratory for student investigation of the problems presented in hydraulics and kindred subjects. This installation is the result of much study and it is believed it will bring much good not only to New Mexico but to other sections where

pumping is depended upon for irrigation purposes. The idea is original with Professor Bixby and the supervision of the installation is under his direction. He has been fortunate in securing donations for this installation to the extent of about $1,500. A number of manufacturers and manufacturers' agents have been very liberal, realizing the importance of this work. It is planned when the plant is completed to prepare a descriptive article of this plant and distribute it widely for the benefit of those interested in pumping for irrigation. The plant is situated in a very conspicuous place and no doubt will be visited by a great many interested people.

The North Carolina College of Agriculture and Mechanical Arts.—The College opened on September 7, with the largest registration in its history. There are 575 students enrolled, an increase of about 16 per cent. over the enrollment for last year.—Examination of the registration shows a decrease in the four-year agricultural enrollment, an increase in the four-year engineering courses, and a considerable increase in all of the short courses both in agriculture and mechanical arts.—The Departments of Civil Engineering, Electrical Engineering, and Chemistry moved into the new Engineering Building during the summer. This building cost approximately $60,000 without equipment. It is in shape somewhat like the letter *H*, there being a large central section with two wings. The over-all dimensions are 170 ft. by 90 ft. The upper floor is occupied by the Department of Chemistry and the Chemical Department of the State Experiment Station. The second floor and the basement are shared equally by the Departments of Civil Engineering and Electrical Engineering.—The Department of Civil Engineering is provided with two large drawing rooms, a lecture room, a cement laboratory, recitation rooms, offices and storage rooms for instruments and supplies. —The Department of Electrical Engineering is provided with a dynamo laboratory, 87 by 29 feet; rooms for storage batteries, photometric work, transformers, shop, stores; an instrument laboratory 28 by 40 feet; a large drawing room; recitation rooms; library, and offices.—The design of the building is colonial. It is constructed of red brick with buff trimmings and with reinforced concrete floors and gypsum partitions, thus rendering it fireproof. It is heated by exhaust steam from the college power house and draws its electrical supply of all kinds from the same source.

University of North Dakota.—The College of Mechanical and Electrical Engineering is making extensive additions to the equipment of its mechanical and dynamo laboratories and wood-working shops.—In the laboratories, are being installed a 30 h.p. De Laval Turbogenerator, a 50 h.p. steam engine, and surface condenser for the same, a 5 in. by 6 in. triplex pump and 20 h.p. motor, a 45 k.w. Fort Wayne generator, a

10 k.w. three-phase rotary converter with transformers, switchboard and accessories, etc., a 7½ h.p. variable-speed interpole motor, five other motors of ½, 2, 5, 5, 15 h.p. respectively. Numerous electrical measuring instruments are also being installed as well as several machines in the wood-working and machine shops. Further additions will be made next year when the $8,500 balance of the recent appropriation will be available.

University of Pittsburgh.—The School of Engineering at the University of Pittsburgh has been obliged to provide new shop equipment and buildings on account of its large Freshman class. Buildings are now being erected, and it is hoped to have at least the first unit in operation by the first of January, 1912.—Due to the coöperative work at the University the shop work is given largely in the freshman year and differs quite materially from that offered in other institutions. Special attention is being given to the study of materials and several new types of oil and gas fire forges are being installed. Rooms will be provided for the study of heat treatment of metals in which will be an extensive equipment of pyrometers. Space will be provided for research work along this line. The shops will be particularly well adapted to the study of shop efficiency; this work to be combined with the coöperative work.

Purdue University.—The friends of the University have been encouraged by the recent bequest of Mr. William C. Smith, late of Williamsport, Indiana. In Mr. Smith's will, recently probated, the sum of $50,000 in cash is bequeathed to the University and 1,500 acres of land in Minnesota, the value of the land being estimated as about $50,000 more. This gift is intended for buildings and other permanent improvements for the Agricultural Department of the institution. The gift was entirely unexpected.—The equipment of the Hydraulic Laboratory is progressing, an 85 k.w. motor-driven, two-stage, centrifugal pump having been installed to supply extraordinary demands for water service. Two other small centrifugal pumps are already available for ordinary experiments.—Mr. F. W. Grieve has just been appointed Instructor in Hydraulics, succeeding Professor George W. Case, who is absent on leave pursuing graduate studies at Cornell University. Mr. Grieve is an alumnus of the University of Wisconsin and has specialized since graduation in hydraulic work.—A new oil-testing machine of rather unique design has just been installed in the Mechanical Laboratory and is being used in making efficiency and endurance tests of some commercial oils. The peculiarity of the machine is the insulation of the test bearing from the other bearings in the apparatus, thus insuring better temperature determinations.—An important demonstration took place on the Purdue farm on Saturday, October 14. This was an xhibition of the working of an Oliver gang plow drawn by three oil traction engines.

The furrows turned were fifty in number, covering a width of nearly sixty feet or approximately seven acres for every mile of travel. This is probably the largest plowing combination in the world and it is believed that all previous records for plowing were broken in this test, one acre being plowed for each four and one quarter minutes of time.—Two new instructors have been added to the Engineering College this fall. Mr. L. L. Vaughan, who graduated from this College in 1899 and then took graduate work at Columbia University, receiving the Degree of M.E. this year, has been appointed Instructor in Mechanical Engineering.—Mr. P. E. Cowgill, a graduate of the Ohio State University and for some time associated with the New York Telephone Company, has been appointed Instructor in Mechanical Drawing.

Throop Polytechnic Institute.—The Institute opened on September 23, for the first time in its history exclusively as a college of engineering, the leasing of the Throop Academy plant to the city of Pasadena marking the end of all work lower than college grade.—The attendance is larger than heretofore in the college work, and there is every prospect for a most successful year. An important addition to the faculty is George A. Damon, B.S., in E.E., Michigan, as Dean of Engineering. Dean Damon has had wide and successful experience in electrical work, and especially traction work, as managing engineer of the Arnold Company, of Chicago, which has made surveys for traction purposes in Chicago, Pittsburgh, and New York, and is now engaged in similar work in Los Angeles.—Other new members of the staff of instruction are W. F. Flint, Ph.D., Yale, Professor of Chemistry, taking the place of W. K. Gaylord; and Charles Emory Barber, A.M., Nebraska, Professor of History and Economics, and recorder, who succeeds Professor B. F. Stacey.—New equipment has been purchased during the summer for the hydraulic, electrical and mechanical laboratories, and further orders for equipment are now being placed.

Tufts College.—Professor Samuel C. Earle, the head of the English Department in the Engineering School of Tufts College, has been appointed as the delegate of the Faculty to make the annual visit to technical schools.—During the past four years it has been customary to appoint a member of the engineering faculty who should spend two weeks in visiting a number of schools selected by the delegate. The chief object in view is that of enabling the instructor to broaden his own perspective by making the acquaintance of the leading educators in his own profession, by observing the pedagogical methods adopted in the leading institutions, and in gaining some knowledge of the educational trend and spirit of such institutions. The visiting delegate is also expected to make a report of his visit at a meeting of the faculty, and

to make a special report to the members of his department.—The adoption of this system has proved to be of such great value to the individual and to the institution that we should regard its discontinuance as a serious loss to the efficiency of the school.

West Virginia University.—Professor Clement Ross Jones, B.S.C.E., M.M.E., who for the past twelve years has been head of the department of mechanical engineering, has been made dean of the College of Engineering. Dean Jones began his official duties by coördinating and reorganizing the work of the College. As it now stands, he has divided the engineering faculty into eight groups, which he has designated as the following departments: Steam and Experimental Engineering, Structural and Hydraulic Engineering, Railway and Highway Engineering, Electrical Enginering, Drawing and Machine Design, Mining Engineering, Mechanics and Applied Mathematics, Mechanic Arts.—Professor W. H. Boughton, who for many years was head of the department of civil enginering, has resigned to accept a position as engineer of construction for Vassar College, where he is now located.—Professor R. B. Brinsmade, who was head of the mining engineering department for the past two years, resigned to take up enginering work in the west. The vacancy in the faculty thus caused has not yet been filled.—Professor E. F. Church, Jr., has been made head of the newly created department of machine design and has been given charge of shop supervision.—Professor W. E. Dickinson has been made Professor in charge of the department of electrical engineering, having formerly been attached to the department of mechanical engineering.—Professor Roland P. Davis, B.S., M.C.E., formerly of the Cornell University faculty, has been elected Associate Professor of Structural and Hydraulic Engineering. He has already begun his work at this institution.—Mr. J. B. Grumbein has been advanced from an instructorship in mechanical engineering to an assistant professorship in experimental engineering.—Mr. Robert H. Chandler, of Summerville, Mass., has been employed as foreman of the pattern-making shop and instructor in wood working.

Williamson Free School of Mechanical Trades.—In recognition of successful and commendable work, done along industrial educational lines, an honorary degree was conferred upon President John M. Shrigley, of Williamson, at the 1911 commencement of Swarthmore College.—President Shrigley's whole life has been devoted to industrial pursuits. For many years previous to taking up the work at Williamson he was connected with what is now the Bement and Miles plant of the Niles, Bement, Pond Co., at the Philadelphia location, in capacities ranging from office executive to member of the firm.—Shortly after severing his connection with the above organization, he was asked by Mr. Williamson's board to act as chief executive for the school, a post which he has held throughout

the twenty years of its life, during which time he has handed diplomas of trade courses to 842 broadly trained young men, who have entered the door of industrial life as mechanics, helping to elevate the social position of the skilled worker. These ever have been a source of satisfaction to one whose belief, as head of a trade-teaching organization, is that the young mechanic, properly trained, has at his command the means of a livelihood, the pleasure coming from a knowledge of ability to accomplish, and the heritage of community respect.

THE ARCHITECTURE OF ENGINEERING SCHOOLS.

BY JAMES M. WHITE,

Professor of Architectural Engineering, University of Illinois.

The principles underlying the science of planning large groups of buildings were well understood centuries ago, but their application to the special problems of the engineering college is a distinctly modern one, which, because of rapidly changing conditions with reference to the relation and importance of the different kinds of instructional and experimental work, requires a new solution every decade. The problem in its true magnitude has been confronted only where campuses have been entirely rebuilt, as proposed at the Universities of California and Minnesota, and in such rare instances as we have here in Pittsburgh in the Carnegie Technical Schools and the Western University of Pennsylvania. Other institutions have individual buildings splendid either architecturally or in their adaptability to certain phases of engineering instruction, such as the Russell Sage Laboratory at Rensselaer and the Carnegie Laboratory of Engineering at Stevens Institute, but most of them are examples of what is possible with limited funds on inadequate ground areas. The engineering building at the University of Pennsylvania is probably the best example in the world of an engineering college under one roof, and though the arrangement has its administrative advantages, with more ground available, the problem would doubtless have been solved very differently.

The single building plan is difficult to treat as an architectural unit because of the varied requirements with regard to story heights, lighting, free floor area, etc., for the several shops and laboratories. If class and drawing room exercises can be confined to the morning and shop and laboratory courses be programed in the afternoon, so as to avoid the

interference due to noise and vibration, the plan is a feasible one. In general, however, the group plan is certain to meet with most favor for the following reasons:

1. The buildings can be isolated sufficiently to diminish the fire hazard and they therefore need not be absolutely fireproof.

2. Laboratories which are objectionable because of noise, vibration or dirt can be isolated. Road laboratories with rattlers, locomotive laboratories and combustion laboratories are instances of the above.

3. The lighting and ventilating are simpler problems.

4. Story heights may be readily varied to suit conditions.

5. Materials and equipment can be more easily handled.

6. The expansion of departments is more readily accomplished.

7. Yard area can be available in immediate connection with each shop and laboratory.

8. The greater the diversity in the purposes to which buildings are put, the more advantageous the group plan becomes.

A successful group plan must be based on a comprehensive administrative plan. In most engineering colleges the departments offering courses leading to a degree, as C.E., M.E., E.E., etc., are the administrative units and buildings are provided for each, while in others, departments of instruction such as surveying, mechanics, structural engineering, hydraulics, etc., are the administrative units, and departments teaching work requiring similar housing are grouped together. The latter method makes the best classification for building purposes, because if one department expands into a new building, the space left will usually be suitable for the remaining departments to use.

A study of our most important colleges shows that in general the offices, class, drawing and computing rooms are in one building, and the shops and laboratories are more or less separated but contain offices, computing rooms and demonstration rooms. With small departments where there is only one section in the advanced courses, many instructors prefer to

have the laboratory, recitation and drawing work in the same building; but this is hardly feasible with a large department where students from other departments are handled in some of the same courses.

There are no absolute standards for the design of the class-room type of building, though they are fairly uniform in arrangement. This is also true of shops, but with laboratories we find a very great diversity, which is not strange when we consider that mechanical engineering instruction requires laboratories for experiments on steam engines and turbines, internal combustion engines, heating and ventilating, refrigeration, compressed air, hoisting apparatus, oil, gas and fuels; and that electrical engineering education requires at least a dynamo laboratory, a high tension laboratory and an electro-chemical laboratory.

For a materials testing laboratory, including cements and road materials, we have about the most varied requirements imaginable; but even they are more nearly standard than are those for the hydraulic, railway, mining, ceramics, and chemical engineering laboratories, which present entirely new sets of conditions.

The most noticeable trend in the development of laboratory work is the demand for out-door space, which has a very important bearing on the selection of a site. The position of the engineering college buildings on the campus is usually near the power house, which is generally at the low point of the grounds. The large amount of power required makes this advisable, and a spur from the coaling track can be run into the laboratory yards. If there are to be two distinct types of building in the group, they should not be laid out in a single quadrangle, but rather in two groups, those of uniform height and style in one, and the laboratories and shop buildings in the other with plenty of out-door space which will vary from that required for lumber storage, a dry kiln and shaving bin in connection with the pattern shop, to several acres for a materials testing laboratory.

The area of six city blocks would not be a too generous

one for the purely technical instructional work of an engineering college expecting an enrollment of 2,000 students in the next ten years, assuming both shop and laboratory instruction to be given. The areas required in the several buildings for a given number of students will depend upon the arrangement of the program, the size of laboratory units, and the method of instruction. At Illinois the shops and laboratories are operated all day, which makes four shop sections possible. The accompanying table gives data concerning the area required per pupil in shops and laboratories, based upon the present facilities at Illinois.

Two years ago the University of Illinois, with both types of building in use five and one half days a week, had 120,000 square feet of net floor area (gross area minus walls and corridors) devoted to technical instruction in the engineering college in shop, laboratory and class room buildings, which was 100 square feet per student. Of this 69 square feet were in laboratory and shop buildings, and 31 square feet in class room buildings. Only five per cent. of the space in the laboratory and shop buildings was in class rooms. The net area in the shop and laboratory buildings was 88 per cent. of the gross area and in the class room type, 63.3 per cent. The relative gross areas may therefore be taken in round numbers at 77 and 49 square feet each per pupil. If, therefore, we should design the laboratories and shops as one-story buildings, and the class-room buildings as three-story structures, the ground area covered by shops and laboratories would be seventy-seven divided by one third of forty-nine, or 4.7 times that for class-room buildings, without considering yard areas. These figures apply only where the relative amounts of laboratory and shop work approximate those at Illinois, with about the same distribution of students in courses. They are not intended as designing data but rather to call attention to the fact that the buildings of secondary importance architecturally will predominate in the scheme.

A study of the recently built shop and laboratory buildings listed below shows that they have been designed as in-

dependent structures, probably because of the impossibility of conforming to the existing conditions. If this conclusion is correct it is the strongest possible argument for the need of a comprehensive campus scheme.

The most interesting points for comparison in these buildings are the type of cross section, the method of lighting, and the kind of floor construction. Shop and laboratory buildings have usually been one story high; forty to sixty feet wide; lighted by monitors as well as side windows; with the trusses spaced close enough to support line shafts, and with floors laid on the ground. The overhead belting interferes with the appearance of the room as well as with supervision and a twenty-five foot spacing for roof trusses is more economical than the ten or twelve feet necessary to support line shafts. The shop with a basement or with unit drive for the machines overcomes both difficulties. To secure a steadier light and wider floor spaces, the saw-tooth roof construction has met with favor, though at the sacrifice of architectural effect.

The laboratory cross-section is also undergoing a change and galleries are being introduced for lighter equipment. The height required for a traveling crane is usually sufficient to allow galleries with a height of ten feet below them, and the galleries need not project enough to interfere with the operation of the crane. This arrangement of space is also economical from the instructional standpoint because of the ease of supervision.

A second gallery might be built for calibration work if the first galleries are built heavily enough for the operation of small engines, pumps and dynamos, and the main floor be reserved for condensers, boilers, gas producers, refrigerating machinery, etc. Such an arrangement would be economical from all points of view, including the handling of equipment by the crane.

The floor construction is an important one to consider because of the heavy wear upon the surface, the need of rigidity, the readiness with which machines can be attached and the facility with which openings can be cut through for pipes and

wiring. A reinforced concrete floor gives the rigidity, but is supposed to have many objections from the other standpoints, most of which are controverted in an article in the *Engineering Magazine for* April, 1911, entitled "Objections to Use of Reinforced Concrete."

The Aberthaw Construction Company, of Boston, has published a very interesting bulletin entitled "Wearing Surfaces for Factory Floors," which, though primarily a discussion of the relative advantages of granolithic and wood floors, gives specifications for other types, such as the composite floor with a tar concrete base, plank sub-floor and maple top flooring, and a wood top floor on a concrete base. Their conclusion is that the granolithic floor, if it can be properly warmed, is the most satisfactory and most economical and that the difficulty of fastening machines to the floor is very much less than generally supposed.

Some other problems about which we might well compare notes are sizes and spacing of drawing desks, and whether drawing rooms should be large enough for more than one section at a time, or whether the combined class and drawing room is best.

What kind of artificial lighting is best in shops? Probably flaming arcs if the roof is of the open truss type. What kind for drawing rooms, individual lights or reflected light? What for class rooms, etc.?

Can shops and laboratories be ventilated more satisfactorily by ridge ventilators, or by monitor sash?

Is it best to heat shops by plenum systems or direct radiation? Is a forced circulation hot water system more comfortable and economical than a steam system with temperature control?

Such descriptions as the following are exceedingly valuable, and every new engineering building should be described in a similar manner and commented on in the BULLETINS of the Society for the Promotion of Engineering Education.

The most recent shop and laboratory buildings are the

Russell Sage Laboratory, described in the *Rensselaer Polytechnic Institute Bulletin* for June, 1909, Volume 8.

The Mason Laboratory at Yale, described in the *Yale Scientific Monthly*, November, 1910.

The Laboratory of Practical Mechanics at Purdue, described in the *Bulletin of the Purdue Alumni Association* for May, 1911.

The Mechanical Laboratory at the University of Nebraska, described in the *Nebraska Blue Print*, Volume 9, 1910.

The Ohio State University Electrical Engineering and Mechanical Engineering Laboratory, described in the *Ohio State Bulletin*, October, 1908, Volume 13, Number 3.

The Hydraulic Laboratory at the University of Wisconsin, described in the *Journal of the Western Society of Engineers*, February, 1908.

The shop and laboratory building at Kansas State Agricultural College.

The latter building has been designed as one wing of a future engineering building, and has a three-story head house and 25 foot laboratory bays, with saw-tooth roof construction. In the materials testing section, the height from the floor to the trusses is 33′ 10″. In the steam laboratory, the engines will be set up high enough to give ample piping space below them.

WENTWORTH INSTITUTE.

BY ARTHUR L. WILLISTON,
Principal of Wentworth Institute.

The purpose of this paper is to describe some of the problems connected with the housing, and the provision for future growth and expansion, of a new educational institution like Wentworth Institute. Many of these problems arise because of the particular type of work that this school purposes to do. A brief description of its educational plan will, therefore, first be given.

Wentworth Institute is a school to "furnish education in the mechanical arts" according to the will of its founder, which means that it is a high-grade trade school of the kind that places its teaching all upon a rational scientific foundation, and supplements the practical training in shop-work with elementary technical instruction. Its aim is to develop artisans and skilled mechanics of a superior type, and also to train men who wish to become inspectors, shop foremen, master mechanics and superintendents for industry.

In looking over the possible field that a school of this grade might occupy a very great variety of branches and sub-departments of industry are found for which courses might very properly be established. It is difficult to choose those that are of most fundamental importance, and entitled to consideration in an initial plan; and it is still more difficult to determine with certainty the list of those that it will become desirable to develop as the institution grows. The plan for future expansion, therefore, must be kept extremely flexible. In order to have some definite goal for the institution to grow toward, however, a plan was adopted, after much consideration and study, which provided for an ultimate scheme of twenty-six day courses and a still larger number of evening courses.

In the initial group of buildings, it was decided to include

three types of courses: first, short practical courses of apprenticeship grade, intended for beginners and persons who have had little practical experience; second, longer and more thorough courses, at least two years in length, intended for persons who hope to rise to positions where they will be required to direct the work of others; and third, evening courses of a very practical character, given in both shops and laboratories, but planned for persons employed in similar lines of work during the day and intended to supplement their daily experience.

The list of courses is as follows:

ONE-YEAR DAY COURSES.

Intended for beginners and persons who have had little practical experience.

Manufacturing Trades:	*Building Trades:*
Machine Work,	Carpentry and Building,
Pattern-Making,	Electric-Wiring,
Foundry Work.	Plumbing.

TWO-YEAR DAY COURSES.

Intended for those who wish to became superior workmen, master mechanics, foremen, etc.

Machine Construction and Tool Design,
Electrical Construction and Operation.

EVENING COURSES.

Intended for those who are employed during the day.

Carpentry and Building,	Machine Design,
Pattern-making,	Practical Mechanics,
Machine Work,	Strength and Properties of Materials,
Tool-Making,	The Steam Engine and the Operation of Power Plants,
Foundry Practice,	Electrical Machinery.
Electric-wiring,	
Plumbing.	
Practical Mathematics,	
Mechanical Drawing,	

The initial problem for the architects was to provide shops, laboratories, drawing-rooms, and class-rooms for these eight-day courses and the corresponding evening courses. The type of instruction that it was proposed to offer influenced the buildings very largely. The shops and large laboratories are the predominating feature in all of the instruction. The drawing-rooms and the class-room instruction are essential but occupy a relatively small place in the completed plan. The one-year and the two-year day courses are intended for different types of students and consequently differ considerably in character and in the distribution of time to the different kinds of instruction.

A typical curriculum for one of the one-year courses would contain the following subjects and approximately the following distribution of time:

(1) Computations and shop calculations, and practical applications of mathematics to various problems related to the particular trade .....5 hours per week.
(2) Applied science, recitations and demonstrations 3 to 5 hours per week.
(3) Applied science laboratory instruction on problems related to the particular trade .....4 to 6 hours per week.
(4) Blue print reading and elementary mechanical drawing 6 hours per week.
(5) Shop practice .....20 hours per week.
Total number of hours per week 40.

A typical curriculum for one of the two-year courses would be approximately as follows:

FIRST YEAR.

(1) Computations and practical applications of mathematics to various problems related to the courses.....5 hours per week.
(2) Applied science, recitations and demonstrations...5 hours per week.
(3) Applied science laboratory instruction.....12 hours per week.
(4) Mechanical drawing and detail designing....6 to 10 hours per week.
(5) Shop practice in fundamental trades.....12 to 16 hours per week.
Total number of hours per week 40.

SECOND YEAR.

(1) Practical mathematics continued.....5 hours per week.
(2) Applied science and elementary technical branches, recitations and demonstrations.....5 to 8 hours per week.
(3) Applied science laboratory instruction in chosen specialty. 8 to 16 hours per week.
(4) Detail designing.....6 to 12 hours per week.
(5) Advanced shop practice in chosen specialty..8 to 16 hours per week.
Total number of hours per week 40.

If the architectural problem had merely been to design a group of buildings that would adequately house the eight courses of instruction that Wentworth Institute will organize, September, 1911, it would have been a comparatively simple one, but it was necessary to provide for the future growth. This growth is likely to be of two kinds. First, the courses that are now being started will grow and demand more room and larger shops and laboratories; and second, new courses preparatory to additional trades and industries will undoubtedly be established. It is impossible to tell with certainty how many new courses will be required and just what occupations such new courses will prepare for. The careful preliminary survey of the field indicated that it was desirable to make provision in the plans for the fully developed institution, after it had grown to the full limit that the present endowment could support, for a list of twenty-six courses divided into four principal groups; but this list, of course, is likely to be added to or subtracted from. About half of these courses are one-year courses of the type intended to train artisans and superior workmen; the other half are two-year courses intended for persons who hope to rise to positions of the grade of foremanships or superintendencies.

As provision must be made in the future, for housing of many and perhaps all of these additional courses besides providing for the growth of the courses now being started, the problem presented to the architects was not only to design an initial group of buildings, but to arrange these buildings so that they may be continuously added to as the institution

grows, and at the same time always give convenient and well arranged floor space for the related departments, on the inside, and a pleasing and symmetrical architectural design and composition on the outside.

Fortunately the site which had been purchased for Wentworth Institute gives ample room to provide for such a possible future development, as it contains between twelve and thirteen acres of land; and the endowment, too, is sufficient to care for a considerable growth. It amounts to about three and one half million dollars exclusive of the site.

In designing buildings for Wentworth Institute many of the same considerations that would influence the design of buildings for an engineering school or university would, of course, apply, but, because of the practical field of education in which Wentworth Institute is engaged, an unusual degree of emphasis must be placed upon certain of these, while comparatively little weight need perhaps be given to others. New considerations, too, that would not apply to schools of a different type, needed to be taken into account. The following extracts form the list of suggestions given to the architects at the beginning of their work, therefore, will be of interest.

1. All of the departments of the Institution should, in appearance and general arrangement of equipment, resemble as closely as possible corresponding departments in commercial manufacturing plants.

2. The Institute should set a high standard in efficient use of floor space and in its plan for simple and direct travel of material and workers from sub-department to sub-department.

3. In order to control the entire student body of a large trade or elementary technical school such as Wentworth Institute, a single entrance or exit close to the general administrative offices of the Institute and in a central building should be provided where pupils from all departments may be required to enter and leave the school.

4. So far as possible the same idea of student control referred to in paragraph No. 3 should be applied in the design and arrangement of the rooms of all sub-departments occupied by students in any given course.

5. As it is probable that some departments of the school will grow and develop much faster than others, it should be possible to provide more

space for them without interfering with the arrangements of other departments or detracting from the architectural effects and the attractiveness of the campus.

6. As large quantities of heavy material must be delivered at frequent intervals to many of the large shops and laboratories, convenient means of delivery must be provided, independent of the main entrances and hall-ways of the buildings.

Every attempt made to design the shops, laboratories, and class-rooms needed for the initial group of courses, and at the same time to provide for the growth into a larger scheme, developed the fact that very few departments of the Institute could be regarded as permanently located on any given floor space. Occasionally some department will be forced to move to make room for the growth of others. In order to accomplish this with as little cost and inconvenience as possible, the best plan found is to follow that adopted by many large manufacturing plants and department stores of providing unobstructed floor space that may be re-arranged and sub-divided at very little expense to suit the changing needs of the various branches of the business.

Of all the methods tried, the best solution was found to be in the adoption of a *standard unit*, or standard building which may be repeated again and again in various locations on the campus. This unit was so chosen that it could be easily and conveniently doubled or trebled or multiplied any number of times. It was also chosen of such dimensions as to permit its convenient division into offices or small class-rooms or good sized lecture rooms or science laboratories or large laboratories and shops by the use of temporary partitions.

A great variety and types of buildings were carefully studied. The advantages and disadvantages of each were considered. The one finally adopted was a three-and-one-half-story and basement building, 48 ft. wide $\times$ 144 ft. long, divided into nine equal bays of 16 ft. each.* A typical floor of this *standard unit*, when used for shop purposes, is shown in

* All dimensions are given to the center lines of the walls or partitions.

Fig. 1. The second floor plan of this standard unit, divided into offices, recitation and lecture rooms, wash-room, instrument room and laboratory, is shown in Fig. 2. It will be noticed that the floor space, with the dimensions chosen, may be divided readily into rooms of convenient size. Where

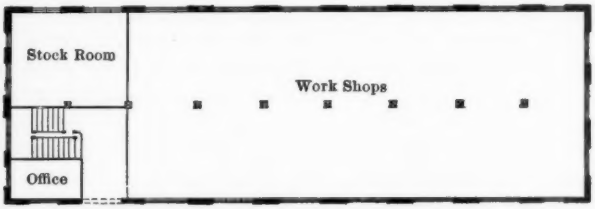


FIG. 1. The *Standard Unit* Divided for Instruction in Shop Practice.

shops or large laboratories or drawing rooms are required, the full width of the building is used, and the rooms may be 32 ft., 48 ft., 64 ft., 80 ft., 96 ft., or 112 ft. long, as desired. Where recitation or lecture rooms are required, a corridor about 8 ft. wide is run on one side of the center row of col-

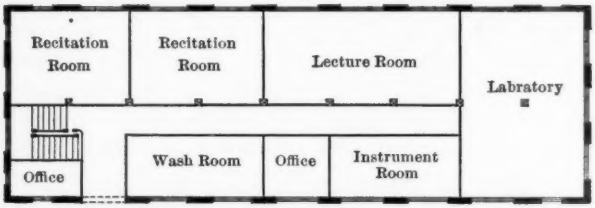


FIG. 2. The *Standard Unit* divided for Recitation Rooms, Lecture Rooms, etc.

umns, making rooms 24 ft. wide on one side of the building, and about 15 ft. or 16 ft. wide on the other. Recitation or lecture rooms are naturally made 24 ft. $\times$ 32 ft., or 24 ft. $\times$ 48 ft. Both of these are very convenient sizes. The narrow space on the other side of the corridor, too, divides itself

readily into offices 16 ft. square, or instrument rooms, wash rooms, etc., 16 ft. × 32 ft. or 16 ft. × 48 ft. It would be difficult to select dimensions for a standard building which could be divided more readily into rooms of convenient size for all sorts of purposes.

Attention should also be called to the selection of a standard building with *nine* bays, and having a width equal to the length of three of the bays. In the first place, the nine bays make it possible to have either one entrance in the center of the building, or two entrances symmetrically located near either end, without having a column on the axis of the entrance. Having the width of the unit equal to one-third of its length, makes it possible to extend a wing to the rear in the center of the building, making a "T"-shaped building, or else to extend two wings to the rear at either end of the building, making a "U"-shaped building, as is desired. If the width of the building was not equal to an even multiple of bays, this could not be done without re-arranging the window spacing. If, too, a smaller dimension than 48 ft. × 144 ft. were chosen, the space between the wings would hardly be sufficient for proper lighting.

The excellent lighting and the general arrangement of the windows and the type of elevation adopted for the standard building, are clearly shown in Fig. 3, which is a photograph of power house and one completed unit. Fig. 4 shows a rear view of the buildings already erected, which include a foundry, one of the standard units, a two story wing about 24 ft. × 48 ft. to connect this unit with the future administration building, and a power-house about 80 ft. square. On the block plan shown in Fig. 5, the completed buildings are shown at *a*, *B*, *C* and the power house.

The departments that have been provided for in these initial buildings are as follows:

In the attic, lighted from above by the skylight, a practical mechanics laboratory, 48 ft sq. with two large stock-rooms. On the third floor, an electrical wiring shop, 24 ft. × 64 ft., a

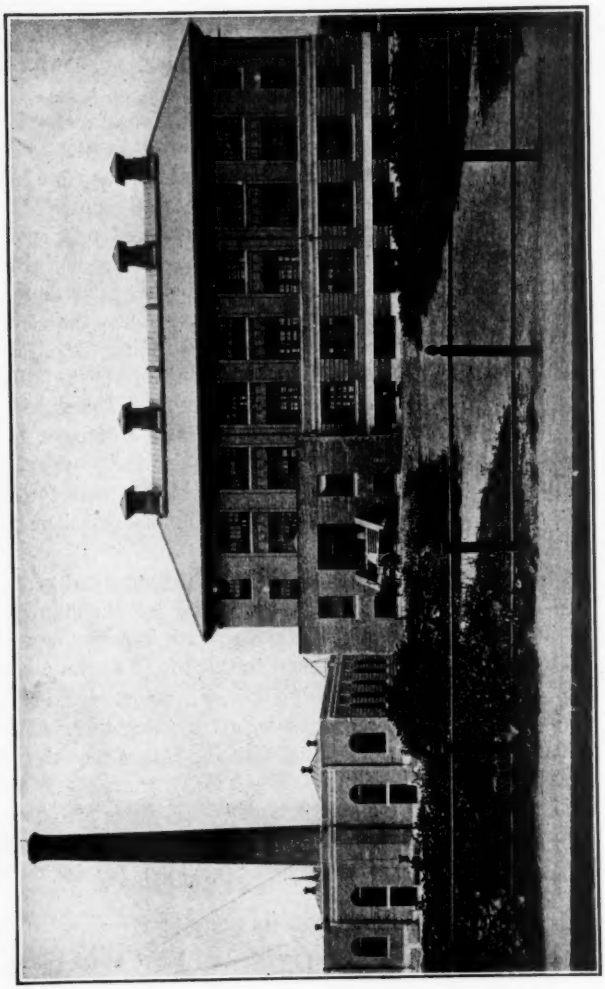


Fig. 3. The Initial Buildings of Wentworth Institute.

FIG. 4. Rear View of Wentworth Institute, Showing Foundry, Shop Building and Power House.

plumbing shop, 24 ft. × 64 ft., a large lecture room, two recitation rooms and three offices.

On the second floor, a drawing room, 32 ft. × 48 ft., a carpenter and pattern shop, 48 ft. × 80 ft., a recitation room and two offices.

On the first floor, the administration offices, machine shop office and stock-room, a machine shop 48 ft. × 80 ft. and a machine design room 32 ft. × 48 ft.

In the basement, which has the same height and lighting as the other floors, is a building materials laboratory, a forge shop, the locker and wash-rooms and certain rooms belonging to the foundry department.

The foundry wing, shown in Fig. 4, is two stories high and gives a working floor space of 48 ft. × 72 ft. with a gallery having a little over half this area. In addition to the working floor space, there are provided in the adjacent portion of the basement of the main shop building a foundry office, a casting cleaning room, a tool-room a supply room, and a small chemical laboratory for foundry-chemistry.

The power house is designed to provide for a very considerable future growth. At the present time, it contains a 200-k.w. generator direct connected to a Corliss engine and a 250-h.p. water-tube boiler. There is room, however, in the plant for a 1,500 horse-power boiler and apparatus to generate an equal amount of electrical energy. Until more space is required for future power plant equipment, however, the space is being utilized in the boiler room, a steam laboratory, and in the engine room for a dynamo laboratory—the plan being to have a railing separate from the apparatus required for power service from that used in experimental work.

Fig. 5 shows in outline the plan that has been laid out for the future growth and development of Wentworth Institute. As has already been stated, the buildings at present in use are the power house, *a*, *B* and *C*. The main administration building, for which working drawings have already been prepared, and which will be the next building erected, is shown at *A*. The buildings, which in the natural course of events,

will probably be erected next, are *a*, *D* and *E*. When this number of buildings have been completed, there will be a symmetrical structure with a dignified entrance and an entrance court of sufficient size to make an excellent appearance.

Sufficient room has been provided on all sides of the group described in the last paragraph to permit extension in any

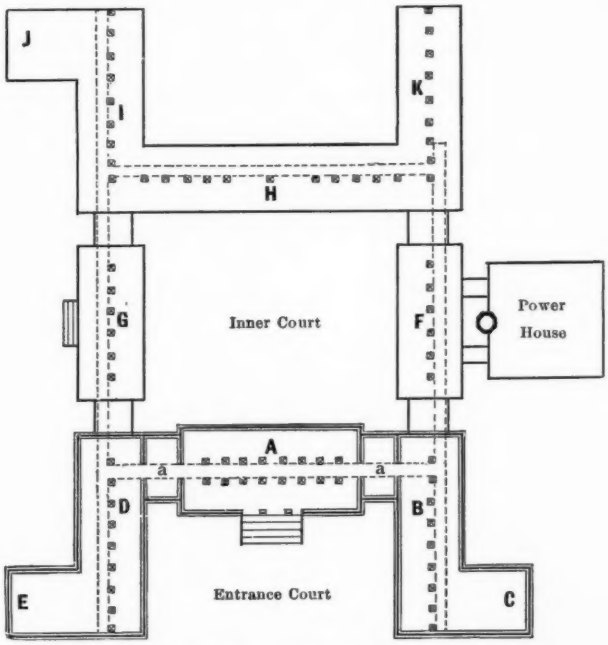


FIG. 5. Block Plan Showing Possible Future Development.

direction; for example, the wing *B* can be extended in length for 96 ft. It can then have a second and third wing parallel to the wing *C* extended at either end of it for a distance of 96 ft.; and these two wings may be connected together in the rear by another building running parallel with *B*, forming a

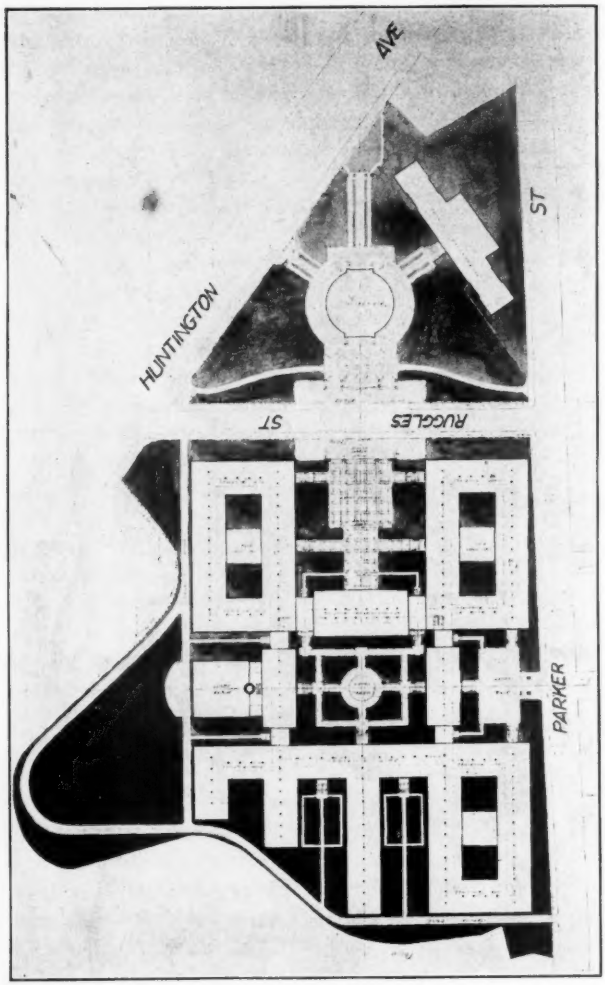


FIG. 6. The Architect's Completed Block Plan.

completed rectangle with two hollow courts 48 ft. sq. If all of these additions were to be made, the completed structure would have a floor space equal to four and one-third of the standard units adopted. But of course, it is not necessary to complete the whole of the buildings. The great variety of ways in which growth can take place shows the flexibility of the plan.

After completing the front group of buildings shown in Fig. 5 at *EDaAaBC*, it is probable that, in place of extending the front as just described, the next development would take place toward the rear, erecting buildings shown at *F*, *G* and *H*. This would create an inner court somewhat larger than the entrance court. At the rear of this, there is still room for additional building, indicated at *K*, *I* and *J*.

Fig. 6 shows the completed block plan as laid out by the architects (Peabody & Stearns, Boston), with buildings indicated at every point where there is space to erect them. In studying this plan, however, it should be kept in mind that it is not necessary for all of the buildings here indicated to be erected, for example, the whole of the front might be completed as indicated in Fig. 6, leaving the rear entirely undeveloped; or, on the other hand, only so much of the front might be completed, as is shown in Fig. 5, and a considerable portion of the rear completed in addition.

One or two more points in the plan shown in Fig. 6 are of sufficient interest to warrant some attention. These are: first, the ease with which it will always be possible to keep a symmetrical arrangement of buildings as the Institution grows after the front group is completed; second, the ease of control of the student body on account of the single entrance and the simple system of corridors connecting together the various buildings; third, the central and convenient location of the administration building, always near the center of the entire group; fourth, the excellent provision for light and air, and fifth, the impressive approach from the Park-way opposite.

TEACHING OF SCIENTIFIC SHOP MANAGEMENT, WITH USE OF ENGINEERING SCHOOL SHOPS AS THE LABORATORY.

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In November, 1909, a "brief" on the desirability of teaching the new science of shop management, based on efficiency engineering, with use of the shops of the School of Engineering as the laboratory, was discussed with the president of the University of Missouri. In the next catalog of the University, printed in April, 1910, appeared in substance the following announcement of the new course to begin in September, 1910.

"*Engineering Shopwork.* Efficiency and Production Management. A shop laboratory course in functional foremanship or staff organization. The planning department. Class observations in elementary scientific time studies. Elimination of wasted time and needless effort. Despatching. Ideal conditions and standardized operations. Charting of production orders. Detailed order-of-work cards. Use of time and instruction cards. Studies of time and load factors. Finance calculations and tests leading to the selection or elimination of machine tools, with reference to the efficiency of the operator, earning capabilities of tool, and hourly overhead burden charges per tool. Tests of maximum economy in cutting speeds, shapes and steels. Tests of power requirements. Experiments on characteristics of general and specialized machines. Exhibits of highly deve'oped machines by manufacturers' demonstrators."

There had been given for two years a course of lectures and reading, required for the M.E. degree, which is still being carried on parallel with the newer course. This is described in the catalog as follows:

"*Scientific Discipline.* A training in the principles of handling of men, as these are becoming well recognized, clearly defined, standardized, tabulated, accepted and used by successful, educated superintendents. The building up and preservation of an organization is more important than the material equipment of an engineering property. The selection

and training of officers. Complaints, penalties and wage systems. The avoidance and handling of labor difficulties. Trades unionism. Methods, dangers and possibilities in the improvement of working conditions."

The two courses make up the special training in *Scientific Shop Management.*

Lecture courses are not infrequent at American universities on the subject of factory management. The features which in the judgment of the joint authors give reason for this paper, are the careful analysis of the principles of scientific discipline, and more especially the use of the college shops as a laboratory in the teaching of scientific engineering shopwork.

Scientific Discipline.—As regards scientific discipline, colleges of engineering are becoming mindful of the strong note of incomplete satisfaction among many of those who receive the raw product of such colleges, voiced from Chicago by one who believes all colleges wholly bad, but hopefully voiced by a president of the American Society of Mechanical Engineers, a "progressive" in this society, whose paternity in efficiency engineering is without question. It is even alleged that the college-bred engineer is only fit to be "used" under direction by the officers higher up, with rare exceptions; and that no great mechanical enterprise owes its success to college men. It is possible that many of these at first unsuccessful young men have placed too great a reliance for future success upon a knowledge of the application of the laws of physical science, to the obscuration of the equal importance of a knowledge of the laws of mental science. This attitude is largely corrected by the teaching of scientific discipline or the handling of men in shops. The principles which lie at the foundation of control of subordinates lend themselves to analysis and logical arrangement. An understanding of these principles, enforced by suitable illustration, applied in numerous ways familiar to every educated superintendent, sends the young man at graduation into the shops prepared to learn the good and reject the bad methods of superior officers, and to act wisely when his own responsibilities come upon him for the first time.

Not everything can be taught in a university. Those subjects certainly can be taught which are open to the "scientific method." A science is a systematic and orderly arrangement of special knowledge, an art is the actual performance of something; the art is doing, the science is knowing why and how. The salesman should better succeed in his art of selling if he can be conscious of being in harmony with the scientific principles governing his art. We know what the science of agriculture is doing for that basic industry of man. In a similar manner, economics is such an applied, practical science. In trade, the fundamental laws have always existed, though long unformulated. Men who traded in harmony with such principles won success. Those who violated these laws had failure thrust upon them in proportion to their violations. Nature is inflexible, and in business as in health and morality, "ignorance of the law excuses no man." The penalty for violation is as great as though for wilful violation. There was a mass of facts, with true relationships concealed. Economics codified the natural laws of trade, makes clear their relations, and places in the grasp of men of affiairs many of the secrets of success and failure. Such is the result of teaching scientific discipline.

Engineering Shopwork.—As regards engineering shopwork, there has long been a feeling among engineering professors that college shops as commonly run were out of place in a scientific course. The deficiencies need not be enumerated here. The spread and excellence of manual training high schools, the coöperative shop courses, the requirement of two years of Arts and Science College work previous to entrance into the School of Engineering course (now in force in the University of Missouri) during which boys from non-manual high schools can have opportunity to make good any lack, have made it possible to introduce what may really be named "engineering shopwork," shopwork in which there are real and serious mental problems waiting on solution. There can be no successful study without a problem to be solved, and therein lies the birth-history of the relation of labora-

tories to the "scientific method." It is true that there are problems outside laboratory courses, as well as the latter without problems, but the laboratory lends itself naturally to the presentation and solution of problems.

Furthermore, the developments of efficiency engineering, centering in the functions of the so-called planning departments or staffs, have furnished a new and very different subject matter as compared to what used to be called "Factory Management." The right management of a complex industrial organization is a science. Not unsystematized management, nor systematized management, but scientific management will secure efficiency. Efficiency is the test of successful management. Efficiency is *not* a method of driving, with resulting physical and nervous hardship; but *is* a securing of far greater output, without any greater fatigue. In the old courses upon factory management, it did not seem feasible to use the common college shops as a laboratory. Such shops were not on a commercial scale of output, wages were not paid, the work of the students was not continuous, the product was not sold, there was no real competition, the primary object was instruction and not profit. But those same shops can to-day be used as a laboratory for the problems of the planning department. Students are being taught to solve the problems in the way they will use in the commercial shop after graduation. Engineering schools which have almost thought to dismantle their shops, can be happy to discover a most important use for them. Splendid as is the coöperative idea—and such shopwork gives a phase of education in man-understanding forever impossible in the college shop—yet until the coöperating shop has been "efficiency-ized," such shopwork will lack the training easily possible in college shops when conducted to teach the engineering shopwork of this paper.

The department of Mechanical Engineering of the University of Missouri has had one year of experience in teaching engineering shopwork. What is there to report to this Society? Of course the before-mentioned ideas were already

known to any teacher who had given the matter thought. Before starting the new course, the authors of this paper made such a study of efficiency engineering and particularly of its application to the management of shops, as was possible for them. One went to a single instance of the installation of the new idea, under especially favorable conditions for getting an understanding of the situation. The plant was in the process of change, some departments having become fully efficiency-ized, and others not. The product was large and varied, a part of the officers sceptical, the efficiency engineer a mighty good fellow who took the professor quite to his heart. The visit was prolonged and invaluable. Later that same engineer came from New England out to Missouri at bare travelling expenses without consultation fee, after one semester of teaching problems had been met more or less satisfactorily, and staid with us one week, working almost day and night. It is proper that we should here publicly thank Mr. Miner Chipman, of the staff of Harrington Emerson. The other author spent a large part of last summer in visiting probably every shop which had introduced or was introducing efficiency engineering in the region included between Topeka, Chicago, Milwaukee, Cincinnati, Pittsburgh to Philadelphia. Also some shops in New York and New England. His more especial attention was given to shops running under Western conditions, if perchance there might be any differences, since the new course was to be given in the Mississippi Basin. As the one author gave somewhat more study to the Emerson methods, so the other author made a special visit upon Mr. F. W. Taylor, and it is also proper for us to give him our thanks. It is believed that a course of this sort can properly be introduced only by professors who have had a responsible shop experience following their actual work as ordinary mechanics, at some previous period in their history.

The course in scientific discipline has been regularly given to classes in full (the outline in this paper being but meager), for the same course has been given for several years.

The course in engineering shopwork was somewhat fully

outlined in the catalog, since we wished to set a high mark which might or might not be reached the first years. The course was made elective the first year, in order not to have an unwieldy class, and that those who were to bear the brunt of pedagogical experiments might do so with eyes wide open. They worked loyally in developing the untried course, and in turn received full value in an understanding of the portion studied. We overheard them telling other students what "good stuff" those other students were missing by not having elected the course. They were always intensely interested.

The students in the course were upperclassmen, and the underclassmen in part were used as a laboratory. First a study was made of the available literature of the subject. This was parcelled out, read, reported upon and discussed. It was realized that the fundamental principles must be studied, and not mere top-heavy systems. Observance of this will make the wise man omit some books and chapters of books now on the market. After the public became interested in the Brandeis hearings the past winter before the Interstate Commerce Commission, the bulk of literature suddenly increased and bids fair to become enormous. A card index of all literature was formed by the class in September.

The class was organized into a staff, each student having a special function to perform. (That this was unwise is shown later.) The personnel contained the following officers: Mill Manager, from the Faculty, Chief of Staff, Engineer, Supt. of Standard Time, Asst. Supt. of Standard Time, Despatcher, Chief Draftsman, Cost Clerk.

Duties of Officers.—Chief of Staff. Keep a record of all meetings of classes, keep a line on all work the men are doing, see that they are doing all of their work, see that no one is infringing upon any one else's work, see that all reports are properly made out and filed, and act as a go-between for the Mill Manager and the Staff.

Engineer. Study the equipment, its efficiency and condition, cost of power, management of shops, arrangement of machines and the installation of new machines, repairs, tools, etc.

Supt. of Standard Time. Make time studies, especially in the machine shop and the forge shop, establish standard time, assist in making shop cards.

Asst. Supt. of Standard Time. Assist Supt. of Standard Time, make time studies, especially in the wood and pattern shops, and in general the same duties as the Supt. of Standard Time.

Despatcher. See that the work goes through without any delay, make suggestions for time cards and drawings, give any spare time to time studies in the machine shop.

Chief Draftsman. See that all drawings necessary are made on time, are correct, and in the best form for the shop conditions.

Cost Clerk. See about the stock on hand, look after the cost of materials, tools and power, and devise a system for rewarding the men for their work that will be suited to the particular conditions of this shop.

All men are to assist in whatever work for which they can spare the time, make as many as possible of their reports in typewriting, all important work to be thus reported on the first Monday following the work, step by step, not waiting for the completion of the job.

The above was the first and most serious mistake. Students are untrained, and their available time is too brief. It is not possible for any one student to do a staff job with proper thoroughness. He will run behind. For example, it would take the entire time of an expert to "dispatch." Hence in college an elaborate system of dispatching is not feasible. Put the boys all together on "records" and again on "time studies." The mistake was not corrected until the beginning of the second semester. It is better to concentrate than to generalize. Where the class is divided into committees, appoint one man in each committee to be responsible for that committee to the Professor, and to see that each man in his committee understands and does what he should.

Staff meetings or planning department conferences were held weekly, at which progress reports were presented both

verbally and in writing. When in writing, duplicates were given to all. The class made a study of each feature concerned in the work of the manual arts shops, such as tool-room methods, small tools, location of machines, improvement of machines, defective belting (a source of great loss), speed-meter work, methods of teachers, methods of students, etc. No subject was too sacred for investigation. In the real thing the very highest offices get investigated, the most serious faults being often found there. Turn a student loose, and trust him that he will find flaws in the way he or his underclass friends are being taught. Not all of his objections are justified, and he may not commonly know the best remedy needed, but happy is that college that is willing to invite the criticisms of its students while they are yet students. To quote from a thesis just read by the authors of this paper: "The University of Missouri, as far as I can ascertain, is the leader at present in the teaching of shop management and the handling of men or scientific discipline, but it will have to continue to improve to hold that place, as great plans are being made by other institutions, notably at Worcester Polytechnic Institute." The effect of the year's work has been good in every way. Students talk efficiency, professors talk efficiency, both have been stimulated, and this is true of those students and professors who have had no personal share in the course. The spirit of the Mechanical Department has not only not suffered, but it has never been finer.

In the above mentioned study, defects were remedied when time and money were available. During all of these preliminary studies, and those to follow, it must not be forgotten that the primary purpose of manual arts shops is educational. Changes are asked or declined as they may affect educational matters, the educational being paramount; changes which would be treated in contrary fashion were the shops commercial. This does not in any way vitiate the application of efficiency. In fact, the peculiar difficulties imposed for pedagogical reasons do actually make clearer the real efficiency principle; revealing the principle as a principle rather than

as a hard and fast system. One of the serious errors into which the half-baked catcher-up of what he thinks is efficiency engineering falls (and we are not at this moment referring to college students), is his taking the shadow for the reality, the system for the principle, the method for the fundamental science. Therefore, instead of the pedagogical limitations being a hindrance, they are really an aid to good teaching of efficiency engineering by compelling the student mind to get out of the rut of the shop thinker. That is why the Emerson articles harp so seemingly interminably upon their everlasting illustrations drawn from trees, human bodies, the Franco-German war, the Nipponese, etc. He wants the reader to see the law, the principle, the general efficiency fact which can be applied in many different ways to industries as varied as steel making, boarding-house keeping and education. Every smallest situation met by an efficiency engineer in a plant is different from all other situations, and he must meet it with a clear knowledge of fundamental scientific principles, so that he may solve the individual difficulty in the peculiar, just-right way. That is why a lawyer of our acquaintance has become so good an efficiency engineer; his previous training had accustomed him to look at every side of a case, impartially, coldly, painstakingly, alert for the weak spot, when found—hot with the quick iron. Your rule-of-thumb, half-baked efficiency (?) engineer (God save the mark) goes and applies a "system," makes a costly botch of his job, maybe the labor union gets justly roiled at his "driving," and the owner or employee or both tell the public that efficiency engineering is guesswork, a farce and a failure. The trouble is, that the pet system was ill-chosen because blindly chosen. Not system, but principles, not methods, but principles, are needed. Scientific management is not a natural outgrowth of systems or even of system. It is not an evolution. It is rather a *reversion to type*. A great industry under scientific management closely resembles in its essentials the small shop, in which the owner and his few men intimately connected with him were studying and working intelligently and harmoniously with a

view to perfecting the operation. In solving the problems of inefficiency in the large shop, the greater burden should rest upon the management and the smaller upon the men. The unscientific large shop has a manager most distantly removed from a vital connection with the operation, and the latter is left to those unable to give it intelligent study. The performance thus becomes the concern of the less intelligent help. The management performed its function when the order went from the office to the shop, and was then free from further concern until the job was completed. Introduction of system has helped some, by following the order and checking it at various stages of the work. The highest development of system, however, has been found to lead, not towards the essentials and a solution of the problem but away from them. Therefore a new start has had to be made in the large shop—a reversion to the small shop type by a discovery and study of fundamental scientific principles. A college is just the place to start young men into right ideas of principles, in the atmosphere of impartiality and investigation.

The class prepared to engage in elementary time and motion studies in machine, forge, and wood shops. For example a simple job of making a pattern was chosen. The work was subdivided into operations. Drawings were made, with each important step shown. A list of all operations was also made out. After a report and conference in the planning department, blue prints of these drawings and lists were issued to the freshmen as detailed order-of-work cards. In a college shop, too much detailing of instructions must be avoided. The freshman must be allowed some initiative and choice of methods, for his own good. Also, for the senior's good, there must be by him a study of all the freshmen in his group, in order that he may learn from them still more of what are the best methods. Then watches were held upon the freshmen and the time taken for each elementary operation. These time studies showed that some of the elements were not sufficiently subdivided for best time and motion study. In actual efficiency engineering practice, it is sometimes a study of months,

to determine elements, before beginning the time study. The senior may need to ask the shop instructor's help and advice. More time studies were taken, results discussed, lost time pointed out. Improvements were made, tending towards ideal conditions. Each machine, for instance, had all necessary tools placed in a tray in the tool room, and the tray issued thence to the workman. The blue print was fastened to a stand convenient to the man's eyes when at work.

This analytical study of minute elements, with the improvements, was followed by synthesis. Out of the synthesis was evolved the science and art of making the article. This science and art take the place of insufficient knowledge and rule-of-thumb method, and *it must be evolved by the management itself,* not by the workman. Scientific management rests upon a definite and sufficient knowledge of everything connected with the manufacturing of a line of goods, and has as its aim efficient production. As in the old, small shop, the brains are now concentrated on the actual making of the article.

"Standard time" for this perfected job of pattern making was discussed by the class, and decided upon. Time cards of the freshmen were assorted, and compared with the standard time. The percentage of efficiency was figured, and a paper-bonus awarded to each of the freshmen earning it. In the college shops, it is probably not wise to tell the shop men what efficiency or bonus the time study on them shows. The work is done for the good of the seniors, and when that good is attained, stop.

Despatching was instituted. A despatch board built. Service cards planned, compared, discussed, adopted. A student would be given two wood lathes and seven wood-working benches to despatch. Without interfering with the instructor, it was "up to" him to keep his freshmen supplied with work, and these two machines busy earning their keep. He was told that he must work without interfering with the education of those freshmen in any way, he must not tell them what to do or what not to do, or how to do anything, therein being in a

predicament similar to the efficiency engineer who is required to institute reforms without killing output. If the senior bothers the class or the instructor, put him out or make him practice time-study on street or university farm laborers; until he comprehends that tact is part of his function. If a shop instructor was found who rather looked askance at what he feared was to be an interfering with his teaching, the situation was welcomed rather than otherwise; it compelled the senior to exercise more tact, and he had to do his work and make the instructor like to have him around. Some one in this audience will call that an unconquerable optimism, a great strain on the senior, a coming up smiling no matter how many underhanded, mean and dirty kicks he gets. That's right! And that is just what a full-grown efficiency engineer has to do. If a man is looking for a nice, easy time of smooth sailing as an efficiency engineer, because he thinks he has the owner on his side, that man is a good one hundred per cent. fool. He must "get solid" with all the unprogressive foremen in the plant, and simply make them like him and believe in his methods. The senior is fortunate if he can have a taste of that sort of thing.

In some of the work, seniors study the work of each other, and sometimes the work of an expert instructor. Competitions were carried on, and the reasons for success and failure were discussed. Street laborers and other workers were informally time-studied by students in off hours. Station stops on the Wabash Railroad were similarly time studied. It was was evident that late trains did not need to be so late, or even late at all in some instances. A study was made of the culinary department at the big University dining hall, a report made to the rest of the class and to the manager of the dining hall.

A side light on using the opportunity was afforded in the semester just ended when our shops were destroyed by fire. Thirty-six hours later, the efficiency class was busy planning temporary shops and equipment, which were installed in record time. It was at this period that the University dining hall was studied.

During the year, a highly specialized machine was brought to the University, and the makers sent an expert demonstrator to operate it. This was used to turn out a very great amount of product, showing such a machine's commercial possibilities. This summer, after correspondence and by invitation of the makers, one of the authors is to spend several days at the makers' works, and show them what is wanted by us next year in their various demonstrations before our students and in our time studies in connection therewith.

Should objection be made that in college there is no method of reward for individual increased efficiency, it ought to be remembered that of the twelve Emerson "principles of efficiency," only the last one is a reward. An efficiency engineer can make tremendous savings by the other eleven. Some efficiency engineers advocate omitting the reward, in cases where at first they may find intense union opposition to the new ideas, or for other sufficient reasons. It is, however, possible to have rewards in college for those who attain greater efficiency. These rewards may be: to let the student out early, to give him advanced work, give him work he desires, higher grades, additional hours towards graduation, money from the manufacture of small duplicate parts for local factories or others near by.

As fast as improved pedagogical methods are found to conserve the students' time, additional items in engineering shopwork will be introduced. Perhaps half of the class will follow the strict Taylor system, the other half the strict Emerson system; or a third group may select from both systems, following neither exactly. Graphs will be made of improvements of men in the machine shop, as they get more familiarity with machine work. The "exception" system of reports will be employed. Studies in fatigue will be carried on, for efficiency engineering must not cause undue fatigue. The department of experimental psychology has become interested, and methods are already in mind for the expert selection of temperaments and physique for certain sorts of shopwork, instead of the existing "judgment" of employer or foreman,

or the long process of cut and try. One of the professors of economics has become intensely interested, and we expect good help from him, and the help will be reciprocal. The President promises to fit up a special shop laboratory for the use of some of the efficiency courses. The superintendent of a large local factory is getting interested, and there promises to be a good laboratory opportunity there. Building and paving operations in town and University afford an extensive field, since the city has doubled and the University trebled in this decade.

It is probable that courses will soon be developed especially adapted for teaching civil engineering students, electrical engineers and chemical engineers. We are thinking of putting the mechanical laboratory and the mechanical drafting rooms on an efficiency basis, making the usual preliminary studies, of course. In fact this year a class in drafting room management, made up of students not in the course in Engineering Shopwork, has outlined the methods for doing this.

Being a state university, we plan later to invite the owners of industries, including the railroads, to detail certain of their officers to come to the university free of charge and take studies in Scientific Management. Woodworking has apparently not been studied after the manner of Taylor's Art of Cutting Metals. It is a cheap material to buy and work, machines and tools are inexpensive, colleges seldom have any superfluity of money, and for the sake of the students a line of research may be entered upon in this subject.

A state university, with its intimate relations to the state, is under special obligations to serve its state. A number of good things along efficiency lines suggest themselves for this service, many of them entirely outside of shopwork. Our comparatively young Engineering Experiment Station may profitably take up some of this work, and thus still further justify its existence by an added service to Missouri, or rather, to all of its inhabitants. A state, especially if largely agricultural, needs extensive, diversified manufacturing industries if it would be well balanced, most prosperous and progressive.

A state university should promote its state's growth and efficiency in this direction.

There is incentive for thought and action in this extract from Frank B. Gilbreth's new book on Motion Study:

"There is no waste of any kind in the world that equals the waste from needless, ill-directed, and ineffective motions. . . . Tremendous savings are possible in the work of everybody—they are not for one class, they are not for the trades only; they are for the offices, the schools, the colleges, the stores, the households, and the farms. . . . It is obvious that these improvements must and will come in time. But there is inestimable loss in every hour of delay. The waste of energy of the workers in the industries today is pitiful. . . . In the meantime, while we are waiting for the politicians and educators to realize the importance of this subject and to create the bureaus and societies to undertake and complete the work, we need not be idle. There is work in abundance to be done. Motion study must be applied to all the industries. Our trade schools and engineering colleges can:

1. Observe the best work of the best workers.
2. Photograph the methods used.
3. Record the methods used.
4. Record outputs.
5. Record costs.
6. Deduce laws.
7. Establish laboratories 'for trying out laws.'
8. Embody laws in instructions.
9. Publish bulletins.
10. Coöperate to spread results and to train the rising generation."

Such, from one qualified to speak by years of expert experience. And yet his words refer to but one phase of the subject of scientific management.

Visits to Columbia began during the semester just ended, for the purpose of investigating what has been attempted. A most cordial invitation is extended to anyone for this purpose at any time during the coming year, when all seniors in mechanical engineering at the University of Missouri will be required to take the courses in engineering shopwork and scientific discipline.

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And many papers in the *Transactions of the American Society of Mechanical Engineers.*